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Therapeutic education of asthmatic children through adapted physical activity

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Abstract

Physical activity is generally reduced in the asthmatic population compared to the healthy population. This physical inactivity is all the more marked when asthma is poorly controlled and obstructive ventilatory disorders persist. Exercise-induced dyspnea is the main mechanism behind the reduction or cessation of daily physical and leisure activities, leading to a vicious circle of poor asthma control and reduced quality of life. This is why the therapeutic education of asthmatic children through physical activities is designed to help them develop their own physical capacities, so that they can better control their asthma on a daily basis. To achieve this goal, we need to have a thorough understanding of the disease, and to handle with care the various means available to us to help asthmatic children develop.

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Introduction:

Physical activity encompasses the collective array of bodily movements elicited by the activation of skeletal muscles, resulting in a significant augmentation of energy expenditure in comparison to the resting metabolic state. The primary objective of this article is to provide a comprehensive synthesis of the scientific literature concerning the pivotal role of physical activity in asthma management and its ramifications with regard to sedentary behavior and quality of life.

It has been well-documented that regular physical activity plays a pivotal role in enhancing the overall health of children afflicted with asthma (Côté A, 2018). The majority of asthmatic individuals, who exhibit well-controlled symptoms within the mild to moderate severity range, can lead lives akin to their non-asthmatic counterparts and actively engage in regular physical activity. In the absence of underlying cardiovascular risk factors, these patients typically do not necessitate specialized assessments prior to resuming or intensifying physical or athletic pursuits (publications H, 2019). In fact, it is important to emphasize that asthma, with the exception of the specialized context of scuba diving, does not serve as a contraindication to sports or high-level athletic endeavors. Notably, the World Anti-Doping Agency endorses the use of the majority of asthma treatments among elite athletes. However, for individuals grappling with uncontrolled or poorly managed asthma, it becomes imperative to tailor the foundational treatment regimen to effectively control asthma symptoms, thereby fostering the perpetuation of physical activity and the attainment of the highest possible quality of life (Raherison C, 2015). The management of this chronic condition also hinges on the reintegration of regular physical activity which is tailored and personalized for these patients within the broader framework of their healthcare.

1- Children's asthma

Globally, nearly 300 million individuals contend with the burden of asthma. It stands as the most prevalent chronic ailment-affecting children, with a prevalence rate ranging from 8 to 10% (Hadef D, 2015). The societal repercussions of asthma are as consequential as its economic toll, exerting a significant adverse impact on the quality of life of affected children and their families.

According to the Global Initiative for Asthma (GINA, 2019), asthma is characterized as a chronic inflammatory affliction of the airways. This persistent inflammation is intrinsically linked to bronchial hyper responsiveness, which, in turn, leads to recurrent episodes of wheezing,

dyspnea, chest tightness, and coughing. These symptoms tend to manifest predominantly during the nocturnal or early morning hours, with variations in terms of their onset, frequency, and intensity observed over time. These clinical manifestations are closely associated with variable expiratory flow, indicating difficulties in expelling air from the lungs due to bronchoconstriction, resulting in airway narrowing.

1.1 Risk Factors for Asthma (Oudjedi A, 2020)

1.1.1 Gender

A heightened risk of asthma is observed in boys, primarily owing to their underdeveloped airways in comparison to girls. This anatomical difference renders them more susceptible to the detrimental effects of secondhand smoke exposure. Conversely, in adulthood, women face an increased susceptibility to asthma, likely attributable to the influence of female sex hormones.

1.1.2 Parental Secondhand Smoke

A significant factor in augmenting the risk of asthma in children is exposure to parental secondhand smoke. This exposure amplifies airway mucosa permeability, thereby increasing vulnerability to asthma.

1.2 Trigger Factors for Asthma (Khelafi R, 2016)

The onset of asthma represents a complex interplay between genetic predispositions and environmental elements, which include:

Indoor Allergens (e.g., mites, mold, dander).

Outdoor Allergens (e.g., pollen and mold).

Tobacco Smoke: Passive smoking emerges as a prominent risk factor for asthma, particularly among exposed children.

Irritant Chemicals in the Workplace (e.g., emissions from chimneys, factory settings).

Air Pollution: Notably, fine particulate matter in the air.

Cold Air

Strong Emotions: Stress and depression have been associated with asthma exacerbations.

Premenstrual Asthma: Approximately 40% of asthmatic patients experience a worsening of asthma symptoms during the premenstrual period.

1.3 Predisposing Factors for Asthma (Magnan, 2019)

Several predisposing factors contribute to an individual's susceptibility to asthma, including:

Family History: A familial allergic background is a significant predisposing factor.

Allergic Rhinitis during Childhood: This condition is associated with a threefold increase in the risk of developing asthma.
Allergic Conjunctivitis.
Prematurity or Low Birth Weight.
Recurrent Bronchiolitis in Childhood.
Obesity: Obesity has also been identified as a contributory factor in asthma development.

2. Physical Activity Levels in Asthmatic Children

The significance of physical activity in asthma control underscores the importance of advocating for physical activity and providing respiratory rehabilitation as part of the comprehensive management of asthmatic patients, in conjunction with the control of comorbidities and pharmacological treatments.

Regular physical activity among asthmatic individuals contributes positively to asthma control and overall quality of life (Carson KV, 2013). The majority of patients with mild to moderate asthma and well-managed symptoms can lead ordinary lives and participate in regular physical activities without necessitating specialized assessments, unless there are concurrent cardiovascular risk factors.

Numerous studies affirm the merits of physical and sporting activities for individuals with asthma. Physical activity, whether undertaken independently or in combination with pharmacological treatments, has the potential to enhance asthma control (Parrat E, 2020).

2.1 The Impact of Asthma on Children:

2.1.1 Respiratory Problems

During physical activity, asthmatic children often encounter exercise-induced dyspnea (shortness of breath). Symptoms encompass a spectrum, ranging from mild coughing to severe respiratory distress. In order of increasing intensity, these symptoms include:

Shortness of breath;
Coughing;
Wheezing;
Chest tightness.

Exercise-induced asthma is intrinsically linked to transient bronchial obstruction, typically occurring 5 to 10 minutes after the cessation of exercise. It results in heightened work for inspiratory muscles and exercise-induced hyperventilation. Bronchoconstriction manifests subsequent to the physiological bronchodilation experienced during physical exertion, leading to reductions in respiratory function, including decreased maximum

expiratory volume and peak expiratory flow rate. The severity of exercise-induced asthma correlates with the stability and severity of the underlying asthma condition. Two principal theories, the thermal theory involving airway temperature variation and the osmotic theory involving airway dehydration, have been proposed to elucidate the bronchoconstriction induced by mouth breathing. In the most severe cases, this condition may necessitate hospitalization (Elsevier, 2016).

2.1.2 Psychological Disorders

Asthma carries significant psychological implications for patients, substantially affecting their ability to lead normal lives. This impact is particularly pronounced in severe asthmatic cases, where social isolation often becomes intertwined with the condition. In children, these consequences may manifest as exemptions from physical education, stigmatization, instances of bullying by peers, and diminished self-confidence. Consequently, there is a palpable reduction in the child's overall well-being and disruptions to their social life. The family environment is also significantly affected, with stress, hyper-vigilance, and recurrent work absences due to crises or hospitalizations shaping the daily lives of families. Additionally, asthma can disrupt children's sleep patterns, and a correlation exists between the severity of asthma, familial support, and the incidence of depression (Perotin-Collard JM, 2017).

2.1.3 Physical Disorders Leading to Deconditioning in Exercise

In the context of respiratory diseases, a detrimental cycle ensues: a combination of physical and psychosocial disturbances sets the stage for deteriorating conditions that foster a spiral of deconditioning. This cycle unfolds with a cascade of consequences. Initially, respiratory ailments give rise to avoidance behaviors. Subsequently, there's a decline in exercise tolerance, accompanied by a gradual physical deconditioning characterized by premature fatigue, reduced physical activity levels, and diminished exercise performance. The asthma trigger threshold, reflective of the level of physical fitness capable of inciting an asthma attack, diminishes over time in correlation with reduced physical activity. These consequences profoundly affect a child's morale, leading to an aversion to experiencing asthma attacks or encountering situations where they might feel inadequate compared to their peers.

This spiral culminates in the child's sedentarization, exacerbating asthma symptoms and the likelihood of asthma attacks. This inactivity necessitates an escalation in medication dosage and heightens the risk of hospitalization.

Consequently, kinesophobia, or the fear of physical activity, takes hold, further diminishing the child's quality of life.

The cardiorespiratory performance of children with asthma is typically constrained or suboptimal (Thio BJ, 1996). This limitation can arise from either restricted exercise tolerance linked to respiratory symptoms stemming from underlying airway obstruction or secondary deconditioning resulting from a lack of physical activity. Asthma and the psychological factors associated with the condition discourage physical activity, leading to deconditioning. Deconditioning, in turn, can precipitate functional decline, further exacerbating inactivity—a direct consequence of sedentary behavior, which itself contributes to functional deterioration. Exercise-induced asthma manifests more severely in children with severe or poorly controlled asthma. The prevalence of exercise-induced asthma is significantly contingent on the baseline severity of the underlying asthma condition. Cabral's study involving 164 children revealed a higher prevalence of exercise-induced asthma among those with moderate to severe asthma in comparison to their mild asthma counterparts (Cabral AL, 1999).

Individuals with asthma tend to spontaneously curtail their physical activity out of apprehension for respiratory discomfort during exercise. In addition to these self-imposed restrictions, parents and the child's immediate environment also play a pivotal role in curtailing exercise participation. Driven by a protective instinct, they may discourage the child from engaging in physical activities, further exacerbating the child's sedentary lifestyle. This limitation carries repercussions that extend beyond mere exercise capacity, impacting overall well-being and social engagement. It manifests as a reduction in self-esteem and participation rates (Coughlin SP, 1988)

2-2- Advantages of Engaging in Physical Activity

Physical activity represents a pivotal factor in determining human health. It can be defined as any bodily movement executed by skeletal muscles, which, in turn, results in an escalation of the metabolic rate compared to the resting energy expenditure.

Promoting physical activity among individuals with asthma yields a plethora of benefits. Foremost among these is the notable reduction in the risk of asthma attacks, thereby affording individuals the opportunity to lead a more active and improved quality of life. The advantages encompass a broad spectrum: enhancement of endurance capacity, manifested through a heightened VO2max; augmentation of the threshold for asthma triggers; personal contentment and improved self-esteem; participation in group

activities leading to social reintegration; and an overall enhancement of the quality of life (Varray A, 1990).

In alignment with recommendations from the World Health Organization, therapeutic guidelines for physical activity in children aged 5 to 17 stipulate a daily accumulation of 60 minutes at a moderate to vigorous intensity level (World Health organization, 1998). These guidelines are universally applicable to children devoid of underlying pathologies, transcending distinctions of sex, race, or ethnicity. The manifold benefits of physical activity encompass the cultivation of a robust musculoskeletal system, bolstering cardiovascular health, nurturing neuromuscular awareness, and addressing the issue of obesity. Physical activity serves as a means to preserve or enhance health, which is conceptually defined as "a state of complete physical, mental, and social well-being."

A plethora of studies (Van Veldhoven NH, 2001); (Engström K, 1991), have underscored the merits of heightened physical activity, yielding the following outcomes:

Elevation in exercise tolerance, marked by an increase in aerobic capacity and bolstering of endurance capacity; attenuation of asthma triggers through the mitigation of hyperventilation during physical exertion; enhancement of personal contentment and self-esteem; reintegration into communal activities; revitalization of social interactions; and an overarching improvement in the quality of life (Ram FS, 2000).

3- The Significance of Therapeutic Education in Conjunction with the Resumption of Physical Activity

The prescription of physical activity should be regarded as an integral component within the comprehensive therapeutic plan negotiated with asthma patients. However, it is crucial to acknowledge that physical activity alone cannot address all the intricacies associated with asthma and its repercussions. Therefore, it is imperative to incorporate physical activity within the broader context of therapeutic education and respiratory rehabilitation, particularly for individuals with severe or inadequately controlled asthma. This non-pharmacological approach, centered on the individual, is well-established in its efficacy in ameliorating dyspnea, enhancing exercise tolerance, elevating quality of life, mitigating anxiety and depression, and reducing the frequency of exacerbations. It acts synergistically with inhaled or systemic drug treatments, which are indispensable for achieving asthma control.

Therapeutic education is designed to empower patients by enhancing their comprehension of their condition, their treatment regimen, and equipping

them with self-care and adaptation skills. Its overarching objective is to enhance adherence to treatment protocols, promote asthma control, and diminish the occurrence of exacerbations.

In the realm of chronic diseases like asthma, therapeutic education assumes a pivotal role. Patient education is an integral facet of the comprehensive treatment and management strategy for individuals grappling with asthma, as underscored in (Boulet LP, 1999). Given asthma's chronic nature, long-term support is imperative, where information dissemination, treatment administration, emotional support, and education are intricately interweaving (Caulin C, 1998). Furthermore, therapeutic education must be attuned to the evolving course of the disease and the patient's lifestyle. It necessitates a structured and organized approach, employing various educational modalities. It is fundamentally a patient-centric endeavor, predicated on a comprehensive educational assessment that delineates the specific skills that patients need to acquire. This process involves the selection of appropriate pedagogical techniques aligned with a coherent educational strategy, subject to periodic reevaluation throughout the patient's ongoing care. This systematic approach empowers healthcare providers to conceptualize education holistically and discern the intricate interplay between its various phases, thereby enabling effective action (Gibson PG, 2001).

As per the guidelines set forth by the National Agency for Accreditation and Assessment of Health, the degree of asthma control is contingent upon several parameters and is categorized into three levels (Gotzsche PC, 2001):

- Unacceptable control: Characterized by the failure to meet one or more of the specified parameters.
- Acceptable control: Attained when all parameters are satisfactorily met.

Optimal control: Achieved when all parameters are strictly within the normal range, rendering the patient asymptomatic. Alternatively, in the context of acceptable control, it denotes the attainment of the finest possible equilibrium between disease control and treatment tolerance (ANAES, 2004).

Surprisingly, the outcomes of a French survey involving 1,024 asthma patients unveiled a stark disparity: merely 11% of the respondents perceived their asthma as uncontrolled, even though 48% admitted to neglecting their prescribed daily maintenance treatment (Haughney J, 2004). A therapeutic education program holds the potential to enlighten a significant proportion of patients about the inadequacy of their asthma control and the possibilities for enhancing their physical capabilities and quality of life (Bäuerle K, 2017). A comprehensive analysis of the literature on therapeutic adherence

in asthma underscores the critical importance of educating, motivating, and actively involving patients in the management of their condition, fostering a genuine partnership between patients and healthcare providers (Laforest L, 2017).

In instances of well-controlled asthma, the primary aim revolves around identifying the minimum effective dose that sustains optimal control while mitigating the daily intake of inhaled corticosteroids (ICS) due to long-term side effects. Typically, the recommended duration for therapeutic adjustments during dose reduction spans three months. Conversely, when asthma remains uncontrolled, the initial step entails the identification of the underlying causes contributing to the lack of control (e.g., non-adherence, improper inhaler usage, risk factors, etc.) and rectifying them. In cases where modifiable factors are absent or inadequate, it becomes imperative to escalate maintenance treatment to the next level (Raherison C M P, 2017).

It is imperative to underscore that suboptimal asthma control poses a significant impediment to engaging in physical activity. Although improving long-term therapeutic adherence constitutes a necessary prerequisite, it alone is insufficient to facilitate the resumption of physical activity. The process of educational diagnosis, often referred to as shared educational assessment or shared situation analysis, plays an indispensable role in comprehending patients' issues and requirements. This assessment enables the modification of health behaviors, such as enhancing physical activity, fostering therapeutic adherence, managing obesity, promoting smoking cessation, and addressing comorbidities. Within the specific context of exercise retraining and the reintroduction of physical activity, patients' short and long-term personal goals (e.g., climbing stairs more effortlessly, resuming daily chores, gardening, etc.) are also taken into consideration. Social and recreational activities, sports, and related pursuits imbue this comprehensive approach with meaning and intrinsic motivation. This holistic perspective facilitates the negotiation of educational objectives, such as the ability to ascend stairs with greater ease

This approach necessitates the establishment of operational objectives, encompassing activities such as the analysis of breathlessness during exercise, the integration of stair climbing into daily routines, and the enhancement of exercise tolerance through retraining, among others. Pedagogical methods, including active, discovery, and experiential approaches, are employed alongside tailored tools such as stairs, endurance training equipment, and dyspnea scales, among others. Patients and their support networks acquire valuable skills in the form of knowledge, self-

awareness, and self-management, enabling them to assume long-term responsibility for their health. This is particularly effective when complemented by psychosocial and motivational support, notably of the self-management variety. The efficacy of the latter is further heightened when conducted through repeated individual interviews (Lundahl B, 2009).

3-1- The Stakeholders in Therapeutic Education

Global asthma guidelines advocate for a patient-centered approach to education. While the roles and engagement of the patient's support network are not explicitly defined, several guidelines, such as those from the (British Thoracic society, 1995), underscore the significance of the family in the educational process. The family is seen as a potential source of partnership, social support, and as a gauge for perceiving the severity of the disease. It is recommended that a designated contact person within the family or a friend be involved in the patient's education, even though the specifics of this role are not extensively delineated. Regrettably, these guidelines tend to provide limited reference to critical factors such as the patient's acceptance of their condition, their coping abilities, their perception of control over their environment (health locus of control), their health-related beliefs and representations, and their subjective and objective needs.

According to these guidelines, the concept of adherence extends beyond mere compliance with treatment. It encompasses all aspects of patient disease management, including adhering to a written action plan in the event of exacerbations, controlling environmental factors, mastering inhalation techniques, documenting symptoms, and attending regular medical appointments. It calls for a rational and collaborative negotiation between members of the healthcare team and the individual with asthma

The main factors of adherence identified in this guide, based on a literature review, are as follows:

Patient perceptions and attitudes towards asthma and their medications,
Health-related behaviors,
Previous experiences,
Complexity of life prior to consultation,
Understanding of the disease and sense of self-efficacy,
Complexity of prescribed treatments.

3-2-The effective implementation of therapeutic education necessitates the application of pedagogical techniques:

- Sensitivity: The provision of personalized information regarding asthma to a patient yields a positive impact on their motivation to learn by enhancing it.

Sensitivity within therapeutic education also extends to public perception (World Health organization, 1998).

- The dissemination of information aims to elucidate the patient's health status, delineate the nature and progression of care, and equip them with the essential elements required for making informed decisions, including whether to accept or decline diagnostic and/or therapeutic procedures. The overarching objective is to furnish information that facilitates the patient's adaptation to their condition and its ensuing consequences (ANAEs, 2000).
- Learning Self-Management of the Disease: Viewing learning through the lens of cognitive psychology reveals it to be an active, accumulative, and progressive process. The learner actively assimilates information and restructures their existing knowledge to facilitate learning. Consequently, it becomes paramount to probe the patient's experiences to deliver information that aligns with their specific needs, enabling comprehension and practical application (Tardif F, 1999).
- Psychosocial Assistance: Caregivers play a pivotal role in reinforcing therapeutic education by offering psychosocial support, thereby encouraging patients to embrace positive behaviors. These interventions empower patients to identify and comprehend their personal perceptions of their illness and treatment, establish individualized goals, and effectively cope with psychosocial factors that may influence their health (d'Ivernois J, 1995).

4- Methods for Exercise Rehabilitation in Children with Asthma

In order to promote physical activity among children with asthma, it is essential to offer them exercise rehabilitation programs that yield multiple benefits. All children with asthma, from a young age, should have the opportunity to engage in regular physical activity and participate in sports at various levels. Sports should be an integral component of a child's daily routine. Furthermore, efforts should be made to rehabilitate children who have been excluded from mainstream sports activities (Bisschop C, 1999).

The overarching objective of these programs is to bring the ventilatory threshold closer to the normative values observed in individuals without asthma. The effectiveness of such interventions depends on several factors, including the age of the participants, gender, motivation, and their initial level of physical fitness (HAS, 2018).

The advantages of exercise rehabilitation for children with asthma are multifaceted:

• Physiological Benefits:

Elevation of the threshold for asthma triggers.

Enhancement of endurance capacity and exercise tolerance.
Reduction in the incidence of exercise-induced bronchospasms.
Maintenance of a healthy weight and body mass index.

• Psychological Benefits:

Decrease in anxiety levels.
Enhanced self-esteem.
Improvement in overall quality of life and crisis management.
Greater acceptance of the disease.
Facilitation of reintegration into social activities.

To accomplish these objectives, rehabilitation efforts must follow a progressive and enjoyable approach to prevent any added frustration. Typically, a sequential approach is preferred, involving a combination of fast and slow exercises to minimize the risk of exercise-induced asthma. To assess progress in enhancing exercise tolerance, the Léger shuttle test is often utilized. This straightforward test offers a means to quantitatively measure improvements in aerobic capacity (Léger LA, 1988).

Once a child has regained an appropriate level of physical activity, it becomes imperative to provide them with the opportunity to engage in activities of their choice. The demonstrated benefits of asthma rehabilitation, particularly in terms of quality of life, underscore the increasing importance of promoting physical activity within this vulnerable group, especially given the current trend toward a more sedentary lifestyle. Generally, avoiding a sedentary lifestyle is advisable, and this advice holds even greater significance for asthmatic children during their growth phases, where psychological factors often contribute to detraining (Guinand C, 2004).

The environmental context plays a pivotal role. Dry and cold conditions should be avoided, which is why swimming is often favored. Nevertheless, there are no sports that are off-limits to asthmatic individuals, with the exception of scuba diving. However, it is recognized that certain sports or physical activities may pose a higher risk for asthmatics, such as running (Bar-Or O, 1992).

4-1- Exercise-Induced Asthma

For individuals with asthma, engaging in physical exercise can have notable benefits, including improvements in cardiopulmonary performance, reduced dyspnea, enhanced quality of life, and a decreased reliance on asthma maintenance medications. However, exercise can also serve as a trigger for asthma attacks, leading to bronchoconstriction. Exercise-induced bronchoconstriction, often referred to as exercise-induced asthma, arises from a temporary constriction of the airways during or, more commonly, after physical activity, and is indicative of bronchial hyperreactivity. It's

important to note that exercise-induced asthma can be severe, potentially resulting in respiratory failure and even fatalities (Weiss P, 2011).

In the case of individuals with asthma, exercise frequently serves as a catalyst for asthma symptoms. Exercise-induced asthma typically manifests during exercise or shortly thereafter. Notably, respiratory symptoms accompanied by significant declines in airway flows are not exclusive to asthmatic individuals; they can also occur in individuals with no prior history of asthma. Consequently, the term "exercise-induced bronchoconstriction" has become the preferred terminology for describing this exercise-related condition (Jonathan P, 2013).

4-1-1- Clinical Variants of Exercise-Induced Asthma

There are distinct clinical forms of exercise-induced asthma, each presenting with its characteristic features:

Typical Form: This form is characterized by wheezing, dyspnea (shortness of breath), and chest tightness, often accompanied by transient airway obstruction following vigorous exercise. Symptoms tend to manifest approximately 5 to 10 minutes after ceasing exercise. It's worth noting that this form can also occur during sustained physical activity.

Atypical Forms: Atypical presentations of exercise-induced asthma may include abnormal dyspnea following exercise, bouts of coughing, chest pain, or a decline in performance compared to peers (e.g., running slower than classmates). Interestingly, some individuals may exhibit a decrease in their maximum expiratory volume despite being asymptomatic. For instance, approximately 25% of children experiencing a decrease in their peak expiratory flow rate of over 20% after exercise do not report any symptoms; they simply curtail their physical and athletic activities (Lezreg M, 2013).

4-1-2- Mechanisms of Exercise-Induced Asthma/Bronchoconstriction

Various mechanisms have been proposed to elucidate the phenomenon of exercise-induced bronchoconstriction. It can be associated with the hyperosmolarity of the bronchial mucosa, a condition triggered by hyperventilation-induced fluid loss. This alteration in osmolarity prompts the release of inflammatory mediators responsible for bronchoconstriction. An alternative theory links bronchoconstriction to thermal phenomena linked to hyperventilation. This theory posits that the initial cooling of the bronchial mucosa is followed by a rebound effect characterized by vasodilation of the bronchial microvasculature, resulting in reduced luminal space due to hyperemia and subsequent edema (MC Fadden Jr, 1994).

The prevalence of exercise-induced bronchoconstriction among asthmatic children can vary significantly, ranging from 40% to 90% (Grzelewski T,

2009). A recent meta-analysis, comprising 66 studies and over 55,000 participants, reported a global average prevalence of exercise-induced bronchoconstriction at approximately 9% in children and adolescents (De Aguiar KB, 2018).

In Algeria, the prevalence of exercise-induced bronchoconstriction was assessed in children aged 10-12 years and found to be 15% using a 6-minute run as a provocation test (Benarab Bouchrit Y, 2011).

Exercise-induced bronchoconstriction is defined as the isolated occurrence of bronchospasm following exercise, while exercise-induced asthma occurs in individuals with chronic asthma symptoms. The mechanism, which is virtually identical for both conditions, centers on the loss of heat and, particularly, water vapor from the respiratory epithelium due to increased ventilation during physical activity.

Specifically, the relative dehydration of the epithelium triggers an intracellular osmotic gradient, leading to the release of inflammatory mediators responsible for bronchoconstriction (Carlsen KH, 2011).

In individuals with asthma, physical exercise commonly serves as a trigger for asthma symptoms. Exercise-induced asthma typically manifests during or shortly after exercise. Notably, respiratory symptoms accompanied by a significant decline in airflow are not exclusive to asthmatic individuals and can be observed in individuals with no history of asthma. Consequently, the term "exercise-induced bronchoconstriction" has become the preferred nomenclature for this condition.

Exercise-induced bronchoconstriction is induced by hyperventilation, which results in fluid loss. This process is characterized by an initial cooling of the bronchial mucosa, followed by a rebound vasodilation of the bronchial microvasculature. In children, it can persist for up to 4 hours following the onset of exercise-induced bronchoconstriction (Marghli Y, 2018).

4-1-3- Diagnosis and Management of Exercise-Induced Bronchoconstriction (EIB)

As per the American Thoracic Society, the diagnosis of exercise-induced bronchoconstriction relies on the observation of a decrease in peak expiratory flow exceeding 10% when compared to the pre-exercise peak expiratory flow, with consideration for the lowest value observed within 30 minutes after exercise. Exercise-induced bronchoconstriction can be categorized as mild if the percentage decline in peak expiratory flow falls within the range of 10% to 25%, moderate if it falls between 25% and 50%, and severe if it exceeds a 50% decrease.

Historically, there was a belief that children with asthma or exercise-induced bronchoconstriction symptoms should be excluded from school or

physical activities. Presently, it is well-established that physical exercise can have beneficial effects in children with asthma if proper measures are taken to prevent exercise-induced bronchoconstriction. Indeed, a training program is highly recommended for children with asthma, with a suggested duration of at least three months, including two 60-minute training sessions per week, adjusted to the child's capabilities (Jonathan P T. S., 2013).

While exercise-induced bronchoconstriction is often spontaneously reversible within 90 minutes, there are instances where the most effective treatment for bronchoconstriction and asthma attacks may be required, namely short-acting beta-2 adrenergic sympathomimetics (Anderson SD, 2006).

5. Why do asthmatics engage in less physical activity?

The primary reason for reduced or discontinued physical activity in individuals with asthma is exertional dyspnea. Dyspnea on exertion in asthmatic patients is a complex issue, involving factors such as airway obstruction, exercise-induced bronchoconstriction, hyperventilation, deconditioning, comorbidities, and side effects from long-term corticosteroid use. Additionally, this dyspnea can have an emotional component, stemming from the apprehension of experiencing asthma symptoms during exercise, which is often heightened by anxiety and/or depression, conditions that are common in individuals with asthma. Identifying these multifaceted factors is crucial for tailoring physical activity prescriptions. However, it's important to note that physical activity alone may not fully address and control all of these contributing factors (Adams RJ, (2004).).

Depression and anxiety are prevalent among asthmatic patients and are linked to feelings of limited control over their health. These emotional states are often more pronounced in asthmatic individuals compared to healthy subjects. Depression and anxiety are associated with reduced physical capacity, lower levels of asthma control, diminished quality of life, and a heightened perception of dyspnea, particularly in individuals with anxiety. Anxiety and depression are frequently connected to poor asthma control. The onset or exacerbation of asthma symptoms during physical exercise, especially during vigorous activities, can induce fear or even panic, leading to a reduction or cessation of physical activity. This is more common when asthma is poorly controlled (Li HL, 2015).

6. Adapted Physical Activity (APA)

Adapted Physical Activity (APA) refers to physical activity that is tailored to the capabilities and specific needs of individuals with chronic illnesses, the elderly, people with disabilities, or other vulnerable populations. It also takes into consideration medical risks, especially those related to cardiovascular health, as well as the preferences and expectations of participants. The objective of APA extends beyond making physical activity accessible; it aims to create conditions conducive to the development of a sustainable personal physical activity plan within the context of an individual's life journey. Physical or sports activities encompass cultural practices that engage the body and encompass various forms of engagement, ranging from playful and occasional to highly specialized and committed activities, often associated with a sports career (Panagiotou M, 2020).

To promote physical activity in children with asthma, it is essential to offer them an exercise rehabilitation program. Such a program offers numerous advantages, including improved lung function, reduced asthma symptoms, increased exercise capacity, enhanced quality of life, and a decreased risk of comorbidities. Asthmatic children, regardless of their age, should be encouraged to engage in normal physical activities and participate in sports at various levels. Physical activity should become an integral part of their daily lives. Moreover, children who may have been excluded from regular sports activities should be provided with the opportunity for rehabilitation. To achieve these goals, rehabilitation should be progressive and enjoyable to prevent potential frustration. Typically, a sequential approach is preferred, involving a mix of fast and slow exercises to minimize the risk of exercise-induced asthma.

In a study conducted by the College of Hospital Pneumologists ((Portel L, 2019), the primary objective was to describe the characteristics of adult patients seeking consultation at a non-university hospital's pulmonology department due to severe asthma.

Physical activity was defined as any bodily movement generated by skeletal muscles that results in energy expenditure. The method of quantifying physical activity involved converting it into METs (Metabolic Equivalent of Task) (Jette M, 1990).

The reported physical activity could range from 0.9 MET (representing activity during sleep) to 18 METs, which corresponds to running at a speed of 17.5 km/h (Ainsworth BE, 2011). For instance, 1 MET corresponds to the energy expenditure level at rest or while sitting in a chair, equivalent to 3.5

ml of oxygen per kilogram per minute. The physical activity, as translated into METs, was then categorized into four levels:

Level 1 (none): This includes no physical activity beyond the basic activities of daily life, or a value below 3 METs.

Level 2 (occasional): It encompasses regular but moderate physical activity, falling within the range of 3 to 5 METs.

Level 3 (regular): This denotes consistent physical activity, ranging from 5 to 7 METs.

Level 4 (frequent): This level involves physical activity occurring at least three times a week, regular sports involvement, competition, or a value exceeding 7 METs.

The study, analyzing data from 1465 patients with severe asthma, revealed that a significant portion of these patients had low levels of physical activity. Specifically, 70% of the patients reported limited or very limited physical activity. Furthermore, the study highlighted a significant relationship between the level of physical activity and various clinical and therapeutic parameters related to asthma

As a result, higher levels of physical activity are associated with improved disease control, as evidenced by a reduction in the percentage of patients with a maximum expiratory volume below 60%. It's important to note that it's not possible to entirely exclude the possibility that good control of severe asthma enables patients to engage in more intense physical activities, including competitive sports. Additionally, this study underscores the high prevalence of comorbidities in severe asthma and the relationship between these comorbidities and physical activity.

Several studies have investigated the impact of physical activity on individuals with asthma. For instance, (Lingner H, 2015) examined the effects of physical activity and respiratory rehabilitation in 201 adults with mild to severe asthma. They observed an increase in the proportion of asthmatics whose condition was controlled by treatment, rising from 33% to 67% during the study. Furthermore, the authors noted improvements in quality of life and moderate increases in ventilatory parameters following respiratory rehabilitation.

Heikkinen (Heikkinen S, 2018) investigated the effects of regular physical activity in 162 asthmatic patients aged 20 to 27 years. Their study revealed that asthma control was better among patients engaged in sustained physical activity, including those who were overweight.

Lastly, according to (Pinto A, 2015), physical activity, particularly aerobic training, contributes to improved asthma control by reducing systemic

inflammation and bronchial hyperactivity. Overall, these various studies support the idea that physical activity plays a crucial role in reducing airway inflammation, and this inflammation tends to be lower in patients who engage in sustained physical activity.

Rehabilitation training is a well-established therapy for respiratory diseases and has a positive impact on secondary prevention. The primary goal of rehabilitation training is to enhance the oxidative capacities of muscles. This involves targeting endurance muscle training and developing type I and IIa muscle fibers, which are resistant to fatigue. Physical training also increases the mitochondrial content of cells, essential for supplying aerobic ATP, which, in turn, facilitates increased oxygen delivery to the muscles. Moreover, endurance training leads to an increase in the maximum capacity of blood flow (Mackie BG, 1983).

Rehabilitation training aims to condition patients for physical exertion, reducing the energy cost associated with it. This results in reduced dyspnea during exertion, improved cardiorespiratory endurance, and an overall enhanced quality of life. The effectiveness of aerobic training depends on various factors, including intensity, duration, frequency of sessions, program duration, and the initial physical condition of the participants. The fundamental principles of training encompass (Astrand PO, 1980):

Intensity: To maintain effectiveness, the training load must be adjusted proportionately to performance improvement, which is dependent on individual fitness levels and age. Intensity can be measured based on a percentage of VO2max, heart rate reserve, perceived exertion, or METs.

Duration: The optimal training duration for improving VO2 max varies based on the type of training. Longer but low-intensity exercises and short but high-intensity exercises may have different effects on asthmatics.

Frequency: This refers to the number of training sessions conducted per week.

Program Length: It is determined by the number of weeks, months, or years over which the training program is conducted.

6-1- Type of training

Physical training involves exposing the body to a workload with sufficient intensity, duration, and frequency to produce a measurable effect, which typically manifests as an improvement in the functions targeted by the training.

6-1-1 Continuous Aerobic Training

Continuous aerobic training entails maintaining a moderate exercise intensity throughout the entire exercise session. The duration of such

training sessions usually falls within the range of 30 to 45 minutes. The exercise load is determined using various methods, including the maximum heart rate (HRmax) achieved during an exercise test, maximum power, ventilatory threshold, maximum speed, or perceived exertion (Borg G, 1990). The exercise intensity for continuous aerobic training typically ranges between 65% and 75% of the maximum power or strength achievable by the individual.

6-1-2 Intermittent Aerobic Training

Intermittent aerobic training, also known as "Interval Training," was developed by cardiologist Professor Reindell. This training method involves a combination of exercises with varying forms, incorporating high-intensity efforts lasting from 10 seconds to 10 minutes (typically exceeding 80% of the theoretical maximum heart rate) and periods of recovery ranging from 30 seconds to 5 minutes (typically below 70% of the theoretical maximum heart rate). Intermittent aerobic training features short work periods that allow for intense muscle engagement and activation of the aerobic oxygen transport system, without significantly relying on anaerobic processes (Hoier B, 2014)

6-2-The consequences of aerobic training

Aerobic training can have several positive consequences on asthmatic children, aiming to improve their exercise capacity and delay the onset of asthma attacks triggered by physical activity.

6-2-1- Cardiovascular Function

Aerobic training leads to several improvements in cardiovascular function. It can induce myocardial hypertrophy, particularly in the left ventricle, leading to an increase in heart mass (Blomqvist CG, 1983). This training also results in an expansion of blood volume, leading to hypervolemia, and can reduce resting blood pressure and heart rate. Additionally, aerobic training promotes the development of new blood capillaries in skeletal muscles, enhancing perfusion.

6-2-2 Respiratory Function

On the respiratory side, aerobic training can enhance various aspects of lung function. It improves gas exchange, increases VO2max (maximum oxygen consumption), and enhances the elimination of carbon dioxide. Aerobic training also contributes to increased endurance of the respiratory muscles, particularly the intercostal muscles and the diaphragm (Blomqvist CG, 1983).

6-2-3 Muscular Function

In terms of muscular function, aerobic training can lead to an increase in mitochondrial density, which is associated with the volume of exercise. Mitochondria play a crucial role in energy production, generating ATP through the utilization of oxygen in the respiratory chain (Lundby C, 2016). Overall, rehabilitation through aerobic training can have a positive impact on both medical and psychosocial aspects. It can reduce asthma symptoms, lower anxiety levels, and alleviate depression, particularly in individuals facing social distress (Mendes FAR, 2010).

7-Assessment of the physical abilities of asthmatic patients

7-1-Field tests

7-1-1- Six-minute walk test (6MWT)

The 6MWT is a valuable tool for assessing physical abilities in various medical conditions, including respiratory disorders. Studies have shown its usefulness in evaluating the physical abilities of patients and the outcomes of respiratory rehabilitation (Holland AE, 2014). In severe asthmatics, the distance covered in the 6MWT is reduced compared to healthy individuals (499 vs. 616 meters) (Cordova-Rivera L, 2018), as well as in mild to moderate asthmatics (462 vs. 608 meters). However, after participating in respiratory rehabilitation programs, patients have demonstrated improvement in their 6MWT performance (Lingner H E. S., 2015).

7-1-2 Stepper 6-Minute Test (6MST)

The 6MST assesses the number of steps taken in 6 minutes and employs similar instructions to those used in the 6MWT (Grosbois JM, 2016). In severe asthmatics, the number of steps taken is reduced, but this parameter also improves following respiratory rehabilitation (Grosbois JM C. J., 2019).

7-1-3 Chair Rise Tests

Chair rise tests are simple and involve measuring the time (in seconds) it takes to rise from a chair 5 or 10 times, or the number of rises achieved in 30 or 60 seconds (Vaidya T, 2017).

8- Physical Activity and Sports Prescription - WHO Recommendations

8-1 Endurance Activities

Endurance activities should be chosen by the patient, can be performed alone or in groups within their usual environment, and should be diversified and enjoyable. These activities can include walking, Nordic walking, jogging, cycling, electric biking, swimming, dancing, cross-country skiing, snowshoeing, and more. The choice of activity should take into account weather conditions, with different physical activities suitable for autumn-

winter and spring-summer, and consideration of air pollution peaks. A personalized prescription may involve targeting a heart rate corresponding to the ventilatory threshold for retraining. It's important to note that individuals with severe bronchoconstriction tend to engage in daily activities for short durations, often less than or equal to 10 minutes (Donaire-Gonzalez D, 2013). Therefore, the objective of respiratory rehabilitation could be to increase the frequency of activity sequences rather than their duration. This approach is particularly relevant for severe asthmatics due to factors such as deconditioning, fear of exertion exacerbated by anxiety and/or depression, dynamic distension, and exercise-induced bronchoconstriction.

8-1-1- Fractionated Activities

Mild to moderate asthmatic individuals often experience less exertional dyspnea when engaging in moderate-intensity fractionated exercises compared to high-intensity or continuous moderate-intensity exercises. Specifically, there is a decrease in the maximum expiratory volume of 4.5%, 7.1%, and 14.8% in response to high-intensity, prolonged (>15 minutes) low-intensity, and intense (6 to 8 minutes) exercises, respectively (O'Neill C, 2017). This highlights the significance of exercise intensity and duration in determining the risk of asthma symptoms during physical activity. Brief and intense exercises, as well as prolonged but low-intensity exercises, tend to be less likely to trigger asthma symptoms. On the other hand, intense exercises of shorter duration are more asthmagenic. Therefore, activities such as long-distance running, now referred to as endurance running, can be asthmagenic when the intensity and ventilation levels are too high (Fruscione, 2021).

8-1-1-2 The Ventilatory Threshold

Hyperventilation is a major contributor to exercise-induced asthma (EIA), making intense exercise more likely to trigger EIA. However, prolonged exercise at an intensity corresponding to the first ventilatory threshold is generally well-tolerated by individuals with asthma. This threshold is often used in exercise rehabilitation programs and is determined during an exercise test by identifying the first inflection point on the ventilation increase curve. It signifies the gradual activation of anaerobic energy processes as exercise intensity increases, while still remaining below the threshold at which ventilation becomes significantly compromised. In practical terms, this threshold is easily recognizable as it corresponds to the onset of dyspnea and may also coincide with the need to switch from nasal to mouth breathing (Benarab-Boucherit Y, 2010).

8-2- Resistance Exercises

Resistance exercises involving the strengthening of upper and lower limb muscles can be performed for 10 to 15 minutes, three times a week. These exercises typically utilize weights (0.5 or 1 kg), elastic bands, and/or a weight bench. The workout may consist of ten exercises, each with sets of 10 repetitions, with 1-minute recovery periods between sets. The choice of weights and exercise intensity should be adjusted by a healthcare professional according to the muscle group being targeted and the patient's fitness level (World Health Organization, 2010).

8-3- Other Types of Exercises

In addition to endurance and resistance exercises, other forms of exercise are recommended as part of a comprehensive physical activity program. These include warm-up and cool-down exercises, often accompanied by stretching routines. For patients with specific needs or vulnerabilities, balance exercises may be included. Certain techniques and methods aimed at controlling ventilation, such as tai chi, yoga, heart rate variability exercises, and low-frequency directed ventilation, may also be considered based on individual patient characteristics. While their effects on asthma control may vary, these methods can be useful in the daily practice of managing asthma (Karen H, 2022).

8-4- Warming Up

Warming up is a crucial component in preventing exercise-induced asthma (EIA). Approximately 40% to 50% of individuals who experience their first episode of EIA undergo a period of reduced reactivity, which can persist for 1 to 4 hours after the initial warm-up exercise (Stickland, 2012).

For children with asthma, a suitable warm-up routine should commence with breathing exercises designed to help control respiration. These exercises may include deep breathing, nasal inhalation, and oral exhalation techniques. Subsequently, the warm-up phase can involve alternating sequences of slow running and walking, or interval training. During interval training, brief periods of higher-intensity effort (25-30 seconds) are interspersed with recovery periods (1 minute 30 to 2 minutes). Another warm-up option is 15 minutes of continuous walking at a slow pace. The recommended duration for an optimal warm-up is typically between 15 to 30 minutes. Importantly, both the beginning and ending of exercise sessions should be gradual and progressive (Audag, 2016).

8-5- Aquatic Activities

Aquatic activities, particularly swimming in a non-chlorinated pool, are often recommended for individuals with asthma. The warm and humid environment of a pool can help reduce the risk of exercise-induced

bronchoconstriction (EIB) and minimize exposure to pollen. Additionally, swimming can provide several benefits, including improved aerobic fitness and enhanced resting lung function, particularly in children and adolescents.
It's essential to note that scuba diving is contraindicated for individuals with uncontrolled asthma. However, some experts may consider scuba diving without decompression stops as a possibility for individuals with mild or well-controlled asthma who are on appropriate background treatments, have no history of moderate to severe or sudden asthma attacks, do not experience exercise-induced asthma or cold-induced symptoms, and meet specific safety criteria. Any decision regarding scuba diving should be made in consultation with healthcare professionals and experts in diving medicine to ensure safety.

8-6- Walking

Walking is a readily accessible physical activity with numerous health benefits. However, studies have shown that individuals with poorly controlled or uncontrolled asthma tend to be less active, and high-intensity walking is less common, especially among women (Cordova-Rivera L G. P., 2018).
In severe asthma populations, daily step counts can decrease significantly. For instance, individuals with severe asthma may take 31% fewer daily steps compared to healthy individuals and 21% fewer steps compared to those with mild to moderate asthma (Bahmer T, 2017).
Using tools like accelerometers and pedometers to monitor the number of steps can be valuable in clinical practice to assess physical activity progress. One study found that over 12 weeks, individuals who used a pedometer increased their daily step count by an average of 2,488 steps, and their performance in the 6-minute walk test improved by an average of 21.9 meters compared to a group of asthmatic patients who did not use a pedometer, demonstrating the short-term benefits of monitoring and increasing daily physical activity (Coelho CM, 2018).

Conclusion:

The prescription of physical activity should be an integral part of the therapeutic plan negotiated with the asthmatic patient. However, physical activity cannot solve all the problems related to asthma and its consequences, hence the importance of integrating it into the framework of therapeutic education for patients with severe or uncontrolled asthma. This non-drug treatment, centered on the person, whose effectiveness has been proven to improve dyspnea, exercise tolerance, quality of life, anxiety and depression,

and reduce exacerbations, will help to optimize the action of inhaled or systemic drug treatments, essential for asthma control.

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